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This invention relates to surgical instruments for applying circular staple sutures when placing anastomoses on hollow organs and, more specifically, to instruments for placing esophageal anastomoses in newborn infants in cases of atresia.

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Known in the present-day surgical practice are surgical instruments for placing circular anastomoses between hollow organs (cf. USSR Author's Certificates Nos 195,041 and 141,589; patents: Great-Britain No.942,122, US No.3,193,165, Canada No.736,256, Switzerland No.407,407, France No.1,349,201 and No.1,461,464, Italy No.674,175 and 724,978, Japan No.456,544, Belgium No.668,917). Said instruments feature a tubular body carrying a staple portion, said tubular body housing a central stem and a movable hollow rod with a cylindrical knife and a staple ejector, a detachable supporting head with depressions for the staple ends to bend and a circular recess at whose bottom a replaceable plastic washer is located.

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Located inside said supporting head, in the course of the instrument operation, are: a stem connecting the supporting head to the staple portion, the cylindrical knife and the tissues being sutured which are fixed between the end faces of the staple and supporting portions of the instrument.

The aforementioned known instruments are impracticable for suturing the esophagus in newborn infants in the case of atresia thereof, this being due to anatomical peculiarities inherent in newborn infants, mostly on account of small size



of their organs, as well as due to fineness and delicacy of the tissues thereof.

An instrument designed for suturing the esophagus in newborn infants should have the diameter of its working portions (i.e. the tubular staple portion and the supporting head) not exceeding 6 or 7 mm, since for placing anastomotic suture said portions are to be introduced into the inner cavity of those sectors of the esophagus which are to be sutured.

10 It is evident that the inner space of the supporting head of such a diameter renders no possibility to accommodate all the components indispensable for obtaining a high quality suture and making an incision to obtain an anastomotic aperture through which the sutured portions are free to intercommunicate.

20 Appertaining to the aforementioned components are: the depressions for the staples to bend, said depressions being provided on the end-face surface of the abovesaid supporting head; the cylindrical knife capable of cutting an aperture for a free communication between the sutured portions of the esophagus; the stem connecting the supporting head of the instrument to the staple portion thereof; the circular recess at the bottom of which the replaceable plastic washer is provided, said recess serving to accommodate the esophageal ends being sutured and to excise the surplus tissue to restore a free permeability of the organ involved.

Besides, to provide a reliable excision of the anastomotic aperture and a minimum traumatic lesion inflicted upon the living tissues, a slit-like gap or

clearance should be provided between the inner surface of said circular recess and the outer surface of the cylindrical knife, said gap or clearance being in excess of the double maximum thickness of the esophageal walls being sutured.

A free space should be left in between the inner surface of the knife and the stem for the lower end of the esophagus constricted with a purse-string or circumflexional suture to freely sink thereinto.

10

Apparently, it is by reason of the difficulties mentioned above that despite the great progress in mechanization of the process of placing sutures during surgical operations and a wide variety of special suturing instruments available, there has been suggested no special instrument up till now which would be capable of placing anastomoses between the esophagus sections in the case of its atresia occurring in newborn infants.

It is therefore a primary object of the present invention to develop a small-size surgical instrument for suturing the esophagus in newborn infants in the case of its atresia.

20

It is a specific object of the present invention to provide such a surgical instrument that would be capable of quickly and reliably placing a circumferential anastomotic suture, as well as of guaranteed<sup>a</sup> undoubtedly excision of the surplus tissue to restore the lumen of the sutured esophagus with a minimum traumatic lesion inflicted upon the tissues thereof during the process of placing an anastomosis.

To accomplish the objects mentioned above, provision is made in the body of the instrument of the invention for an elastic or springy member capable of insuring a constant rate of travel of the staple ejector at various rates of travel of the rod carrying a puncher, whereas the central stem is free to move reciprocally along the body and to rotate round its own axis when extended all the way out of the body.

10 With a view to attaining a simple and reliable operation of the instrument, said elastic member is made as a split washer loosely set over the tailpiece of the puncher and located inside the instrument body between the end of the rod and the end face of the staple ejector which is likewise set freely on the tailpiece of said puncher.

With the purpose of space saving the cutting device has a puncher associated with the rod and adapted to interact during the operation with the edge of a cylindrical depression or recess provided at the face end of the supporting head for the puncher projection to fit thereinto.

20 According to the invention, said puncher is provided with a cylindrical projection for the tissues being sutured to insert into said cylindrical depression or recess in the supporting head.

In accordance with the present invention, with the purpose of convenience the central stem has a cylindrical tailpiece with a knurled or milled surface whereas the

supporting head has flat spots for a reliable hold on said head by a clamping tool.

An embodiment of the present invention is described hereinbelow by way of example with reference to the appended drawings, wherein:

Figs 1 and 2 are, respectively, a side elevation and a plan view of the surgical instrument for suturing hollow organs in infants;

10 Fig.3 is a longitudinal section of the working (effective) portion of the instrument shown in Figs 1 and 2;

Fig.4 is a section taken on line A-A of Fig.3;

Fig.5 is a section taken on line B-B of Fig.1; and

Fig.6 is a functional diagram of the instrument according to the invention.

Referring to Figs 1 and 2, the instrument of the invention comprises an oblong tubular body 1, a movable handle 2 articulated with the body in the rear portion thereof and a stationary handle 3 rigidly coupled to the body 1.

20 Located inside the front portion of the body 1 is a splined bushing 4 fixed in position so as to form staple slots 5 (Figs 3,4) in combination with the inner surface of the body.

A tubular rod 6 passes inside said tubular body 1, said rod carrying at its front end a puncher 7 threaded thereonto, which puncher 7 carries on its tailpiece 8 a cylindrical-shaped staple ejector 9 and a split spring washer 10, both

of them loosely set thereon. It is by virtue of said washer 10 that a possibility arises for the puncher 7 to move with respect to the staple ejector 9 for a length corresponding to the suturing gap spacing range or, in other words, the provision of said spring washer makes it possible, with the travel rate of the staple ejector 9 being invariable, for the travel rate of the rod 6 along with the puncher 7 to vary within a required range.

10 The front end of the puncher is fashioned as a cylindrical projection 11 which extends beyond the body 1 (Figs 1,3).

The rod 6 is movable lengthwise the instrument body by means of a leverage incorporating the stationary handle 3 and the movable handle 2 whose actuating arm 12 is fork-shaped and is adapted to enter into the body 1 through an opening 12 therein so as to <sup>r</sup>staddle the rod 6 on its lateral surfaces 14 (Fig.1).

In order to fix the movable handle 2 in place a swivel safety lock 15 (Figs 1,2) is provided.

20 Spaced round the periphery of the cylindrical staple ejector 9 are toothlike pins 16 adapted to fit into the staple slots 5 and to drive the staples out therefrom under the action of the rod 6 (Fig.3).

Running inside the tubular rod 6 and the puncher 7 is a stem 17 whose front pointed end 18 is screwed into a supporting head 19. A tailpiece 20 of that stem is



cylinder-shaped, its outer surface being knurled or milled to make it convenient to manipulate with (Figs 1,2,3).

The supporting head 19 is made up of two portions, that is, tapered<sup>e</sup> 21 and cylindrical 22, so interconnected that the tapered portion can rotate independently round its axis, with the cylindrical portion remaining immovable (Fig.3).

10 Provided in the rear butt portion of the supporting head 19 is a cylindrical recess 23 for the lower end of the esophagus being sutured to insert forcibly by virtue of the cylindrical projection 11 on the puncher 7 (Figs 3 and 6).

Spaced round the periphery of the butt portion of the supporting head are staple bending depressions 24. In order to insure that the supporting head be set in a strictly definite position with respect to the stem 17, provision is made in its cylindrical portion 22 for a guide key 25 held in place thereto, whereas an endlong groove 26 (Fig.3) is provided at the pointed end 18 of the stem 17.

20 The tapered portion 21 of the head is provided with two flat spots 27 for a reliable hold on the supporting head 19 by a clamping tool (Figs 1,2).

In order to insure that the staple slots 5 in the body 1 be in a strict alignment with the staple bending depressions 24 made at the butt end of the supporting head 19, the stem 17 occupies a strictly oriented position with respect to the instrument body 1. This is attained due to the provision of a washer 28 having a profiled opening whose shape corresponds

to that of the cross-sectional area of the stem 17, as well as due to the presence of projections 30 adapted to fit into the corresponding slots in the body 1 (Fig.5).

The washer 28 is fixed to the body 1 by means of a nut 31 (Figs 1,2,5).

The stem 17 is provided with two transverse slots 32, 33 and an annular recess or cannellure 34 (Fig.1).

The slot 32 in co-operation with a swivel retainer 35 serves to set a required suturing gap (Fig.1).

10

It is by virtue of the slot 32 running aslant relative to the axis of the stem 17 that the lower portion of the retainer 35, while sliding over the walls of the slot 32, causes the supporting head 19 either to approach the front butt end of the body 1 or to move from it <sup>away</sup> within the spacing range of the suturing gap.

The slot 33 serves for locking the stem 17 through the use of the same retainer 35 in such a position that its pointed end 18 is completely retracted inside the body 1.

20

The cannellure 34 makes it possible for the stem 17 to rotate about its own axis at the very moment when the cannellure is aligned with the profiled opening 29 in the washer 28, viz, with the pointed end 18 of the stem 17 extended all the way out of the body 1.

## INSTRUMENT APPLICATION TECHNIQUE

Prior to making use of the instrument it should be loaded with staples and sterilized.

This done, the instrument is to be prepared for operation, for which purpose the movable handle 2 is locked with the safety lock 15, the supporting head 19 is disconnected from the instrument and the pointed end 18 of the stem 17 is inserted into the body 1, whereupon the stem is fixed in that position with the retainer 35.

10 Then, the body 1 of the instrument is to be introduced perorally into the upper blind section of the patient's esophagus.

The cylindrical projection 11 jutting out from the body having reached the bottom of the upper blind section of the esophagus, the stem 17 is released by swivelling the retainer 35 and is moved all the way forward. This results in that the pointed end 18 of the stem 17 pierces the bottom of the esophagus to penetrate into the operational wound, the cylindrical projection 11 penetrating into the wound through said hole together with the stem 17.

20 By making use of any clamping tool, the tapered portion 21 of the supporting head 19 is held by its flat spots 27 provided for the purpose, and is introduced into the operational wound to fit over the pointed end 18 of the stem 17 so that the guide key 25 of the cylindrical portion 22 of

said head engages the endlong groove 26 in the stem 17. Thereupon the stem is to be rotated by holding it by its tailpiece 20 until it is screwed right home into the tapered portion 21 of the supporting head 19. When assuming that position the stem 17 is free to rotate, since the cannellure 34 provided thereon is located in the profiled opening 29 in the washer 28.

10 Having been made fast on the stem 17, the head 19 is introduced into the lumen of the lower section of the esophagus. This done, a purse-string or circumflexional suture is drawn tight round the stem 17 and tied up thereon, said suture being preliminarily placed on the edge of the lower section of the esophagus.

20 Then, the head 19 together with the lower end of the esophagus fixed thereto is brought by the tailpiece 20 of the stem 17 close to the instrument body 1. When so doing, the lower end of the esophagus drawn tight with a purse-string or circumflexional suture rests with its edge against the projection 11 of the puncher 7 extending out of the upper blind section of the esophagus and is thus made to insert into the recess 23 in the supporting head 19, whereby both the upper blind section and the lower section of the esophagus can be juxtaposed correctly and tightly. Then the stem 17 together with the supporting head 19 is fixed in that position with the swivel retainer 35 whose end fits into the transverse slot 32.

Furthermore, the movable hand 2 is released by turning the safety lock 15 and is pressed upon, whereby suturing is attained.

At the moment the handles 2 and 3 are brought together, a circular staple suture is placed and an excision of the tissues is performed to provide for a free communication between the upper blind section and the lower sections of the esophagus that have been sutured (Fig.6).

10      Formation of an anastomotic aperture in the sutured sections of the esophagus is effected by the puncher 7 which, while interacting with the sharp edge 37 of the cylindrical portion 22 of the supporting head 19 by its bevelled edge 36, punches out a round aperture.

Upon the formation of an anastomosis the movable handle 2 is brought to the initial position and is fixed therein with the safety lock 15.

20      Then, the stem 17 is released by swivelling the retainer 35 and is moved forward, thus causing the supporting head 19 to move away from the body. Next, the body 1 of the instrument is likewise moved slightly forward. Owing to the tapered shape of the working end 36 of the body 1 it is free to pass inside the sutured sections of the esophagus and through the anastomotic suture thus obtained.

Once the working end of the instrument body has passed beyond the anastomotic suture, the supporting head is brought by the stem close to the body, whereupon the entire instrument is extracted from the esophagus.

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A surgical instrument for suturing hollow organs in infants, comprising; an oblong tubular body with an open tapered front end having staple slots spaced around the periphery thereof an oblong hollow rod passing inside said body and capable of axial movement therealong; a cylindrical staple ejector loosely set on said rod and provided with toothlike pins spaced around the periphery thereof so as to fit into said slots in the body; an elastic or springy member providing a constant travel rate of said staple ejector, a stem mounted inside said hollow rod so as to be free to move axially and to rotate around its own axis when extended all the way out of said body, said stem having its front end pointed and extendable out of the front end of said body and also having a tailpiece, said elastic or springy member being essentially a split washer loosely set on the tailpiece of a puncher inside the body between the end of the rod and the butt end of the staple ejector which is set likewise loosely on said tailpiece of said puncher, a tapered head having flat spots on the surface thereof, said tapered head being detachably mounted at the front end of said stem and facing with its wider end portion towards the body, staple bending depressions spaced around the periphery of the butt end of said tapered head, a tissue cutting device, means for movable association of said stem with the rear portion of said body, an actuating mechanism for axial movement of said rod and said staple ejector whereby staples are driven out of said slots, pierce the tissues being sutured and are then bent in said depressions.
2. An instrument as claimed in Claim 1, wherein said cutting device incorporates a puncher associated with the rod so as to interact during the operation with the edge of a cylindrical

recess made at the butt end of said supporting head for the end of said puncher to fit thereinto.

3. An instrument as claimed in Claim 1, wherein said puncher of said cutting device is provided with a cylindrical projection for forced insertion of the tissues being sutured into said cylindrical recess in the supporting head.

4. An instrument as claimed in Claim 1, wherein said central stem has a cylindrical tailpiece provided with knurled or milled surface.

5. An instrument as claimed in Claim 1, wherein said supporting head has flat spots on its surface for a reliable hold on said head by a clamping tool.

6. An instrument for suturing hollow organs of small diameters, comprising: an oblong tubular body with an open tapered front end featuring staple slots spaced around the periphery thereof; an oblong hollow rod passing inside said body and capable of axial movement therealong; a cylindrical staple ejector loosely set on said rod and provided with toothlike pins spaced round the periphery thereof so as to fit into said slots in the body; a stem mounted inside said rod so as to be free to move axially and to rotate round its own axis when extended all the way out of said body, said stem having its front end pointed, which pointed stem end is extendable out of the front end of said body, said stem having a tailpiece; a supporting head being detachably mounted at the front tapered end of said stem and facing with its butt portion backwards, i.e., towards the body; cylindrical recesses and staple bending depressions provided in the butt end of said supporting head; a means for movable association of said stem with the body; an actuating mechanism for axial movement of said rod and said staple ejector, whereby staples are driven out of said slots in the body, pierce the tissue being

sutured and are bent in said depressions, an improvement comprising: a tissue cutting device attached on the front end of said rod and designed as a puncher interacting during the operation with the edge of a cylindrical recess, and provided with a tailpiece and cylindrical projection for forced insertion of the tissues being sutured into said cylindrical recess; a springy member loosely set on said tailpiece of the puncher and being bent under pressure of the butt end of said rod during the movement of said puncher with respect to the staple ejector.

7. An instrument as claimed in Claim 6, wherein said springy member is essentially a split washer.



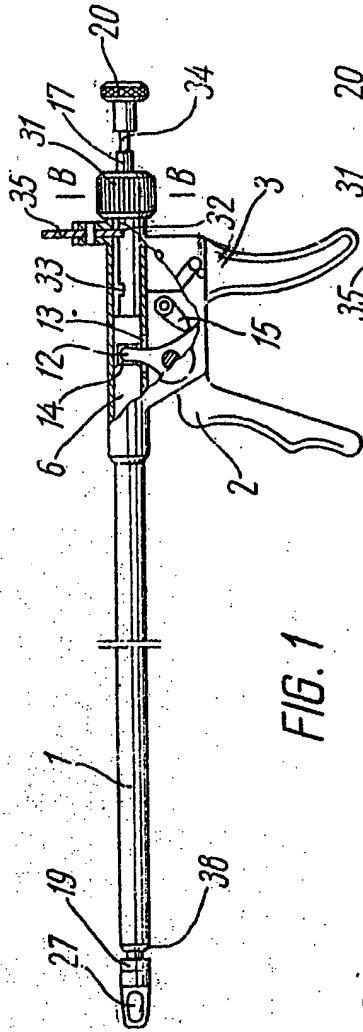


FIG. 1

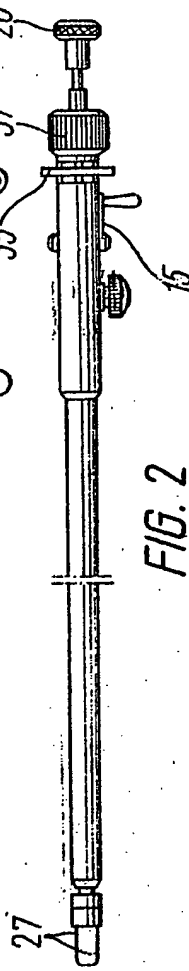


FIG. 2

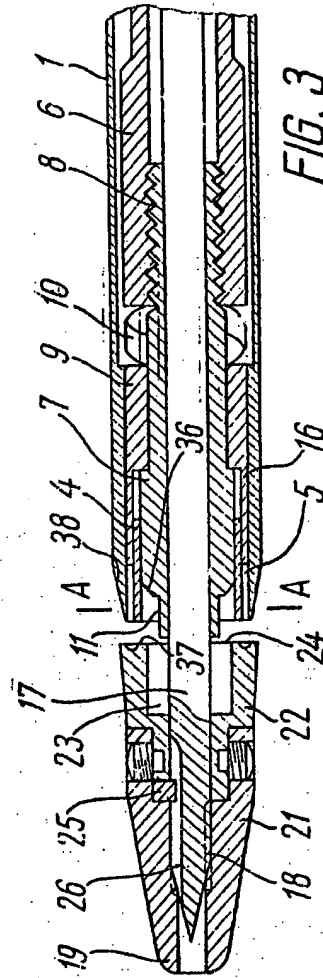


FIG. 3

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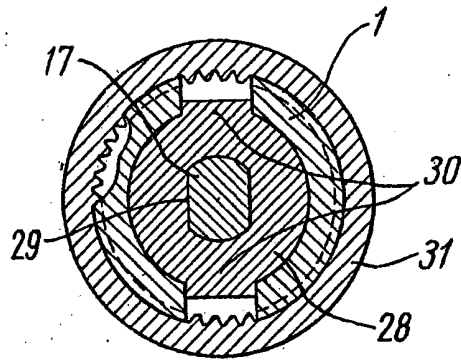


FIG. 5

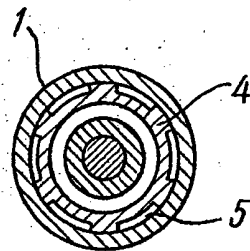


FIG. 4

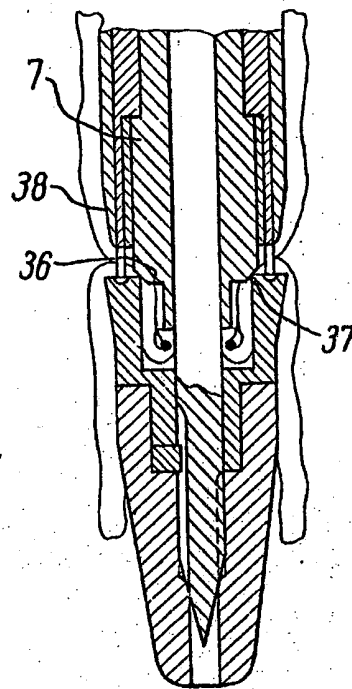


FIG. 6

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